CONDUCT OF THE MASTOID OPERATION

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FOR THE

CURE OF CHRONIC PURULENT OTORRHŒA

WITH SPECIAL REFERENCE TO THE IMMEDIATE HEALING OF THE CAVITY IN THE BONE LEFT BY THE OPERATION BY MEANS OF EPITHELIAL GRAFTS

BY

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TOGETHER WITH REMARKS ON THE CASES WHICH REQUIRE THE OPERATION

By SIR WILLIAM DALBY

[*From Volume 83 of the 'Medico-Chirurgical Transactions'*]

LONDON

PUBLISHED BY THE ROYAL MEDICAL AND CHIRURGICAL SOCIETY AND SOLD BY H. K. LEWIS, 136, GOWER STREET, W.C

1900

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Received December 13th, 1899—Read January 23rd, 1900

In no department of surgery has more progress been made during the last twenty years than in the surgical treatment of chronic suppurations of the temporal bone and the complications which arise therefrom.

This progress has been due to an increase in real knowledge, in part pathological and in part anatomical. The natural history of suppurations in the tympano-antral cavities has been made clear by the labours of many

workers. The anatomical variations in the position of the important structures in relation to and within the temporal bone being now clearly recognised, the surgeon no longer dreads injury to the facial nerve, the horizontal semicircular canal, the sinus lateralis, or a low-lying middle fossa.

There is nothing special about suppuration in the middle ear except its environment by tissues, lesion of which puts life in danger. Suppuration in the temporal bone follows the same course as suppuration in cavities of any other bone, say the tibia, and successful practice in recent years in abating and curing chronic purulent otorrhœa has been due, in large measure, to a recognition of this truth.

It was written in 1889 [1] with unerring insight: "Otology is an offshoot of surgery, and only in close adherence to it and in the true and conscientious observance of its principles is success to be sought for and to be found. The most important principle is the care for free, unhindered, spontaneous drainage. Incomplete drainage and, as a consequence, further and deeper bone disease is the cause of the difficulty in healing middle ear suppurations."

It is not possible to lay down a series of rules which shall guide the surgeon in his choice of cases for operation. When brain symptoms, so-called, arise, no one doubts the desirability of removing the source of infection; but when this *indicatio vitalis* is present, the surgeon has not only to consider the removal of the temporal bone disease, but also a far graver question, namely, the relief of intra-cranial inflammation by operation.

There are other cases of chronic middle ear suppuration in which no doubt can be felt by any reasonable person that operation is indicated. These patients may present one or more of the following signs:—Optic neuritis; attacks of malaise, with fever and headache; vomiting; vertigo;

[1] Stacke, 'Berl. klin. Wochenschrift,' 1889.

atresia of the meatus; pain in the ear; sudden onset of facial palsy; mastoid abscess or tenderness; carious fistula over mastoid; polypoid granulations springing from a demonstrable carious focus in tympanum or attic; or cholesteatoma.

It is to be remembered that polypoid granulations are, as Macewen has stated, protective in a sense against infection, and their imperfect removal through the meatus exposes a raw surface to the action of virulent bacteria. Many years ago one of my patients died after such an operation from cerebellar abscess. I believe the abscess was latent at the time of my operation, for several months previously another surgeon had curetted the tympanum. The patient had subsequently been very ill for three or four weeks with vomiting, vertigo, headache, and retraction of the head. At the time I first saw this patient she was apparently in good general health.

Lastly there are the cases without any mastoid or other signs, in which all minor treatment (such as removal of ossicles, antiseptic dressings) fails, and the discharge, offensive or odourless as the case may be, persists. It is in this last class that wide experience is the best guide. In some immediate operation may be recommended even without any preliminary treatment. The intuitive knowledge born of past experience will be the guide of the surgeon, though if he be asked to put the reasons for the course advocated into writing, he will in some cases be wise to refuse, as experience cannot always be translated into the English language. I do not allude further to the vexed and difficult problem of the selection of cases for operation, for Sir William Dalby's remarks, founded on a ripe experience, are directed to its illumination.

This paper deals with the operation for chronic disease. The same operation is not applicable to acute cases. In certain cases of acute profuse otorrhœa without mastoid signs, and in all with acute mastoid inflammation, the antrum, or the antrum and any other mastoid cells which may be suppurating, should alone be opened. The tym-

panum and meatus should be undisturbed. The operation therefore in acute cases is a local operation limited to the mastoid. The posterior wall of the meatus should not be interfered with, except in that small group of patients in whom the mastoid is involved by infection from the posterior wall of the osseous meatus. These are sometimes influenzal in origin. The object to be attained is comparable to that which is the hope of the surgeon in the case of a patient with acute suppuration of a joint, namely by free drainage and antiseptic flushing to arrest the inflammatory process. In the case of the tympanum another reason exists for the operation, namely, the prevention of the destruction of the delicate structures of the middle ear and the conservation of the function of hearing.

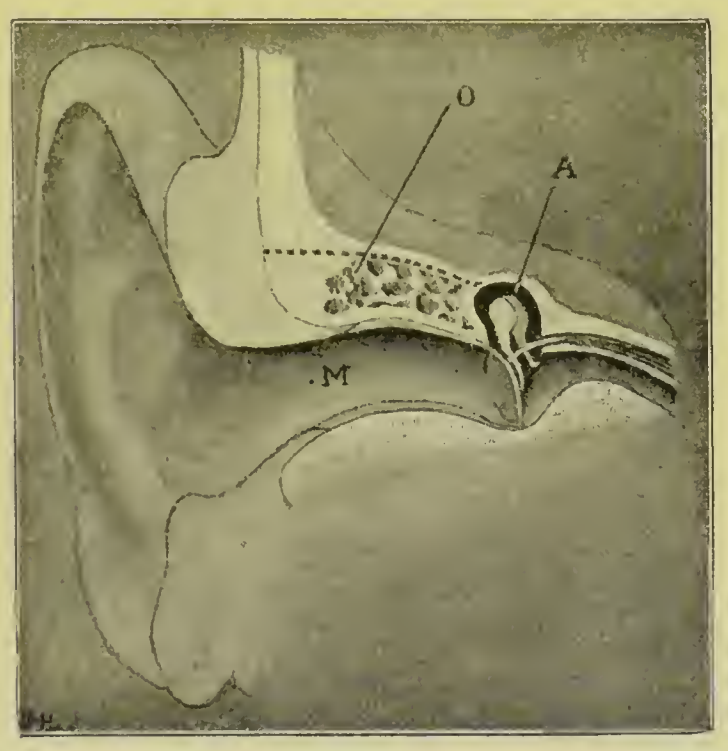
Kuster,[1] from the surgical stand-point, pointed out "that the simple opening of the antrum could have but a limited influence on chronic middle ear suppuration, and for the reason that the communication between antrum and tympanum is small and, in such cases, apt to be still further narrowed by granulations and swollen mucous membrane.

"The rational treatment of chronic otorrhœa is, therefore, to open up fully and extensively the diseased bony cavities, to bring the source of the suppuration clearly into view, and to secure the removal of all diseased tissue. Only when this is done are surgical requirements fulfilled."

The attempt to cure cases of chronic otorrhœa without removing the bridge which overhangs the communication between the antrum behind and the attico-tympanal cavities in front, is to act in opposition to this fundamental principle of surgery. It is my desire specially to accentuate this cardinal fact, because it has many times happened to me to have to perform the complete mastoid operation months or years after an operation had been

[1] 'Berl. klin. Wochenschrift,' 1889. Quoted from Allen's admirable monograph on the mastoid operation.

done leaving the bridge unremoved. On the inner side of the bridge I have observed infective granulations, caries, small encapsuled abscesses, and an open Fallopian aqueduct. There is no part of all the operation which requires more care and thoroughness in the extirpation of disease than here.

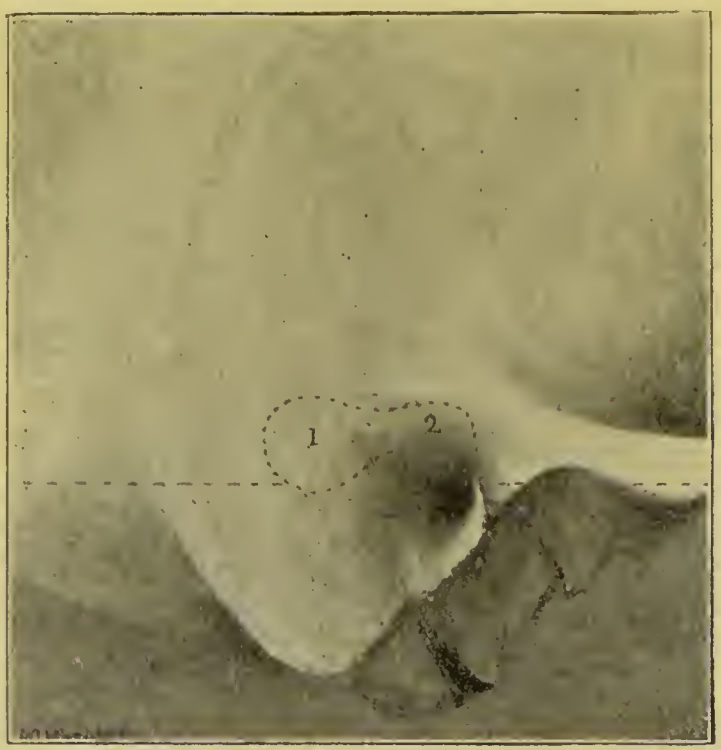


Drawing of a coronal section showing attic, tympanum, and the bone forming roof of meatus.

M = Meatus.
A = Attic.
O = Portion of temporal bone forming roof of osseous meatus and outer wall of attic. In it are seen the cells of Kirchner, which are frequently the site of suppuration. To expose the attic properly the roof of the meatus must be removed as far upwards as the dotted line. If this is not done the surgical principles on which the successful treatment of chronic suppuration in a rigid (bony) walled cavity, such as the attic, is based, are contravened.

The outer wall of the attic is formed by the bone of the roof of the osseous meatus. The thickness of the bone here varies greatly, but it contains cells which communicate with those of the mastoid process and with the attic. The removal of the outer wall of the attic, there-

fore, not only enables disease of this cavity to be extirpated, but it provides for the extirpation of infective granulations and pus, which are very likely to have extended from the attic into the cells of the roof of the meatus. The test of the perfection of the removal of the outer wall of the attic is made by causing a bent probe to touch the tegmen tympani, when on withdrawal out-



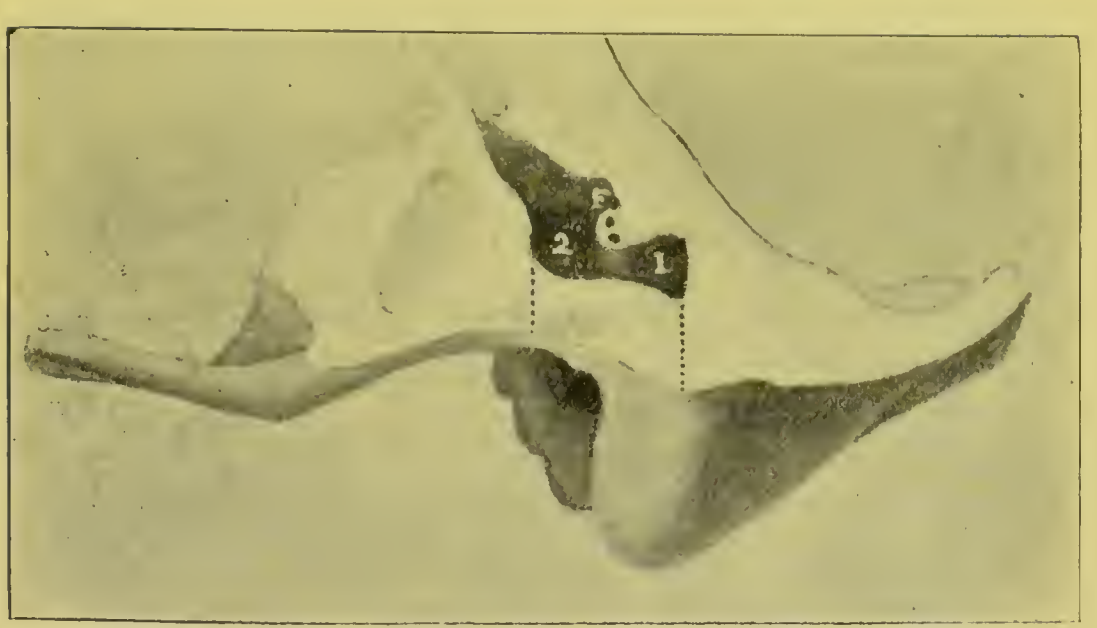
Drawn from a skull in my possession. The dotted line encloses the outer lateral boundary of the antrum and attic.

1 = Outer wall of antrum.
2 = Outer wall of attic.

In cases of chronic suppuration it is essential to completely remove the outer boundaries of these cavities.

wards it should meet with no resistance. Unless this plan is systematically and carefully carried out, diseased tissue will escape the curette, and remaining unmolested by the operator will be a potent influence antagonising the successful issue of the operation.

The tendency of modern surgery is against the per-



Horizontal section of temporal bone, showing between the dotted lines the outer lateral walls of attic and antrum, which are removed in the complete mastoid operation. 1 = Antrum. 2 = Attic. F = Recess of the aqueduct. External to the recess is seen the tuberosity through which passes the Fallopian aqueduct and the horizontal semicircular canal.

Section of another temporal bone on which the complete mastoid operation has been performed. Note that the outer lateral walls of attic and antrum have been removed. 1 = Antrum. 2 = Attic. N = Canal of facial nerve.

formance of type or formal operations; for example, we do not perform formal excision of the knee-joint; we endeavour to remove all disease. So also in the complete mastoid operation for chronic otorrhœa we perform no formal operation. The basis of the operative procedure is in part *pathological*, and in part *surgical*. From the pathological point of view we follow the disease in every direction and remove every trace of it. From the surgical point of view we throw the various bony cavities—tympanum, attic, and antrum—into one. Further, by the removal of the posterior wall of the bony meatus, the inner walls of the tympano-antral-attic cavities are caused to be easily accessible for examination and treatment through the enlarged meatus.

The successful conduct of the treatment for the cure of chronic otorrhœa requires the fulfilment of two conditions: (1) The removal of all disease by operation; (2) The healing of the large bone wound from the bottom.

The second condition has been carried out during the last few years by tamponning the cavity at frequent intervals with strips of dry antiseptic gauze. This plan gives excellent results if the patient remains for many months under the care of the surgeon who is specially interested in the final and perfect result of the operation he has performed. The tamponning, however gently carried out, is painful. The horizontal cut through the cartilaginous meatus must be kept wide open so as to give free access to the inner wall of the antrum. Moreover, the inner extremity of the cartilaginous meatus has a tendency to exhibit prominent granulations and to heal over,—leaving behind it an unhealed cavity.

All those who have had large experience in mastoid operations will agree that the tamponning proceeding is tedious and often fails, especially in hospital patients, to whom the amount of personal attention required can often not be given, and who frequently fail after a few weeks to attend the hospital, until perhaps months or years

later they present themselves again with an abscess in the scar over the mastoid or with persistent discharge.

The last case I treated in this way was a gentleman, aged 35, who had had left chronic otorrhœa, pain and vertigo for nearly twenty-five years. The operation was done last February, Sir W. Dalby and Mr. Cumberbatch being present and assisting. The patient was highly neurotic, and the subsequent plugging of the bone wound efficiently was only done under great difficulties. We all thought that a particularly satisfactory result was obtained when, after a period of seven months, the healing process was complete.

In order to obviate the painful, prolonged, and unsatisfactory after-treatment of the operation, I propose that in future chronic otorrhœa should be treated by two remedial operations instead of one.

The first operation may be called *the operation for the removal of the disease.*

The second operation may be called *the operation for the healing of the wound*

The latter is attained by the epithelial grafting of the tegmina antri and tympani, of the inner walls of the antrum, attic and tympanum, and of the fresh-cut bone forming the anterior and superior walls of the inner extremity of the enlarged osseous meatus.

I have not written an historical account of the rise of the operation for the cure of chronic purulent otorrhœa; nor have I referred to the writings of others, from which I have learned a great deal, and to which I owe probably more than I know. The following is a description of my own plan of operation, which has been developed from no inconsiderable experience. At the end of the paper is appended a list of cases treated in the manner described.

Description of First Operation.

It is hardly necessary at the present day to urge the mportance of sterilising instruments, ligatures, and

dressings; or the duty of making the skin of the patient around the operation area, and the hands of the operator and his assistants, as surgically clean as possible.

The incision commences above, and half an inch in front of the meatus in the line of the hair. It is carried backwards, and then backwards and downwards, still following the line of the hair till that line passes on to the neck. It is then continued downwards and forwards to the posterior part of the apex of the mastoid. The incision is a modification of the incision of Chaput, and, of course, all incisions for mastoid operations date from the classical incision of Wilde. The skin is raised for a third of an inch towards the pinna, and then another curved incision is made right down to the bone. All structures superficial to the bone are raised by the elevator as far forwards as the posterior wall of the meatus, exposing the linea temporalis and the supra-meatal spine of Henle. Surgically, it is essential to expose the mastoid completely. No harm results. The operator gains by the full view he obtains of the external anatomy of the bone, and by the freedom with which he can conduct the operative procedure. A rake retractor [1] seems the best for holding forward the pinna.

The next question which demands solution is—How is the bone to be removed? I am confident that, considering the anatomical variations in the position of the middle fossa and sinus lateralis, no drill or trephine ought ever to be employed on the mastoid. Twice I have seen a small trephine perforate the thin cortex of the mastoid and plunge into a forward-lying sinus. The most beautiful, efficient, and gentle instrument for the purpose is the burr driven by an electric motor. I think the round cross-cut cavity burr made for me by Ash and Co. does better work than the ordinary cavity burr recommended by Macewen. I employ usually two burrs,

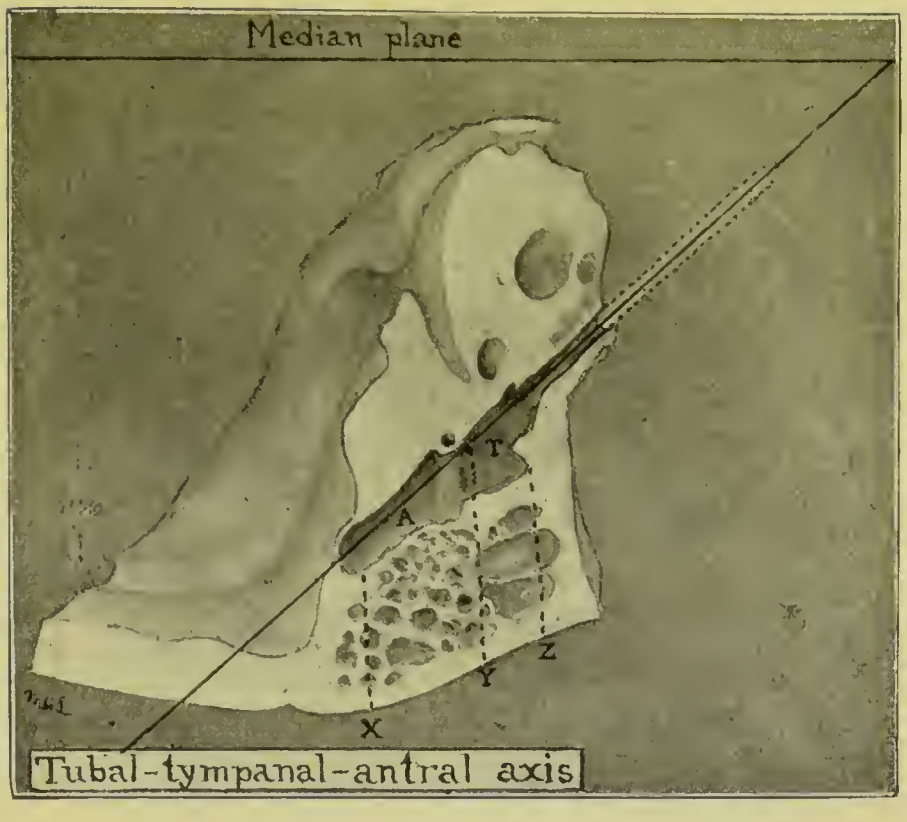
[1] The pinna may be held forwards by a piece of gauze passed through the meatus. This plan is of importance at the second operation, as it obviates the oozing of blood from the granulations.

one 9 mm. and the other 7 mm across. The 9 mm. burr is the most useful; a larger one requires more power than I can conveniently obtain from my motor. Other burrs I have by me in case of necessity are 4 mm. and 11 mm. in diameter. The bone must be kept moist by a trickling stream of antiseptic fluid. The burr must not be pressed against the bone, but should be kept in constant movement over the area which has to be removed. The end of each burr should be so made that it will cut in the direction of its axis nearly as well as at any angle to it. This is usually accomplished by running one of the blades across the top of the burr and making a gutter on each side of it for clearing purposes. I have had each burr fitted with a protector, by means of which the most delicate removal of bone may be accomplished with safety in the most dangerous situations. Formerly I constantly employed these protectors, but I seldom use them now. When the neck of the antrum is large enough, Cryer's drill may be substituted for the burr, and employed to divide the bridge and remove the outer wall of the attic. The motor and accumulators were kindly designed for me by my friend Dr. Trouton, F.R.S., Assistant Professor of Physics in Trinity College, Dublin, and were made by Messrs. Curtis, of St. Stephen's Green, Dublin. The object aimed at was to obtain sufficient power within the limits of portability. The box containing the motor weighs about twenty-five pounds, and the accumulators have the same weight.

If no motor and burr is available, recourse must be had to the gouge. For the removal of the bone superficial to the antrum I use three gouges, with cutting edges 15, 11, and 8 mm. wide. The edge of each gouge should be at right angles to the shaft, like those used by wood carvers. If it is curved it is not possible to know where the cutting edge is. The handle of the gouge should be large so that the hand can grip it well, and smooth so that force can be applied without hurting the hand. I

do not use the mallet except for the removal of the outer walls of the antrum and attic. For this latter purpose two smaller and longer gouges, with cutting edges 5 and 7 mm. wide respectively, have been selected, and while they are in use Stacke's protector serves to shield from injury the tuberosity which projects from the inner wall into the neck of the antrum; it contains the Fallopian aqueduct and the horizontal semicircular canal. The posterior wall of the osseous meatus is best cut down with a pair of small, angular, bone-cutting forceps. This wall must be removed as much as possible, so as to give free access afterwards to the tympano-antral cavities.

It is desirable to make the superficial opening into the mastoid large and roomy, otherwise unnecessary difficulty will arise in performing the more delicate portion of the operation in the deeper parts of the bone. In cases where the antrum is very deep it is useful to remember that the tubo-tympanic antral axis forms an angle of about 45° with the antero-posterior median plane. The antrum, therefore, always lies superficial to the inner wall of the tympanum, the depth of which can readily be measured by a probe passed down the osseous meatus as its upper and posterior walls are exposed in the wound. It need never happen that the antrum be not reached, as some operators have described, for the attic can always be found, and a bent probe passed backwards from the attic into the antrum will be a sure guide to the exposure of this cavity. It often happens that the dura mater over the middle fossa or lateral sinus is exposed by the disease or by the operator. This need not excite alarm, as an extra-dural operation is, comparatively speaking, without risk. Moreover, it is clearly better to have an aseptic cavity bounded by dura than dura in contact with fœtid granulations and pus. When the exposed dura is inflamed and granulating, care must be taken not to injure or perforate the softened membrane with the curette. Some years ago I operated on a child three years of age in the Hospital for Sick Children, Great



Specimen prepared by Hamilton Ballance. Drawing shows section through temporal bone at an angle of about 30° with the horizontal plane. The antrum, tympanum, and Eustachian tube are seen. They form together a line which passes downwards, inwards, and forwards, to which the term "Tubal-tympanal-Eustachian" axis has been given. This axis forms an angle of about 45° with the antero-posterior median plane.

A = Antrum.

T = Tympanum.

The dotted lines Y and Z indicate the position at a lower level of the bony meatus.

The line X leading to outer wall of antrum must always be shorter than the line Y which extends to inner wall of tympanum.

The antrum therefore always lies superficial to the inner wall of tympanum, the depth of which can readily be measured during an operation by a probe passed down the osseous meatus.

Ormond Street, suffering from very extensive caries and necrosis of the temporal bone. The bone forming the roof of the attic and roof of the tympanum had been destroyed by the disease, as had also, for some distance, the bony groove of the lateral sinus. All the exposed dura was granulating, and was left severely alone. Nevertheless, on the second morning after the operation the

child was found almost dead in bed from hæmorrhage from an opening at the junction of the superior petrosal and lateral sinuses.[1]

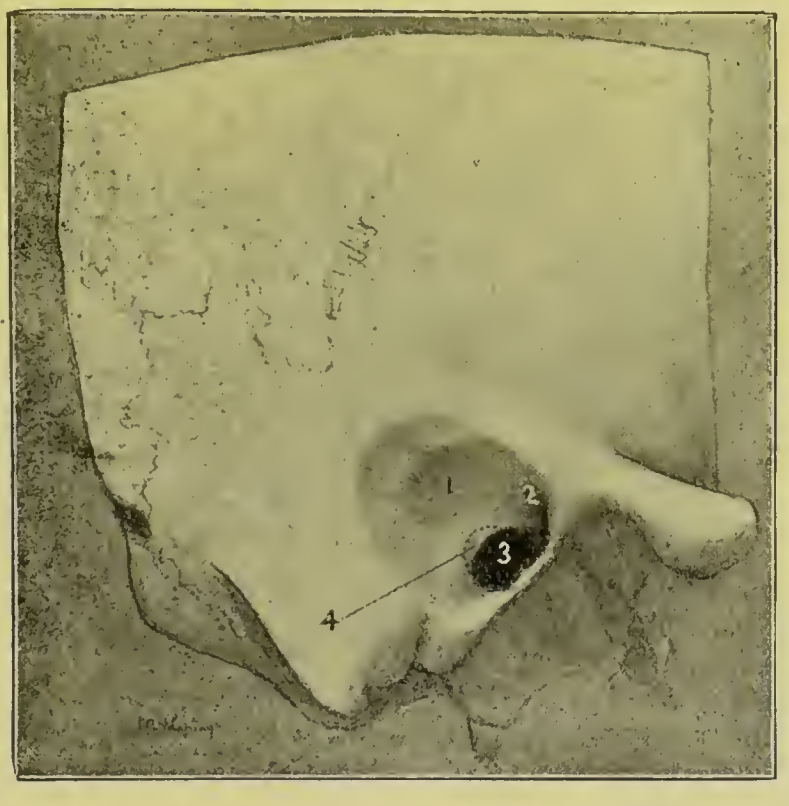
Sharp spoons of various sizes are used to remove the diseased granulations and soft parts from antrum, attic, and tympanum. The tegmina antri and tympani, and the inner walls of these cavities, should be left by the spoon clean and hard. A bright light is required to do this well, and temporary plugging with dry gauze is an important aid. During this part of the operation, if the aqueduct is open the spoon may touch the facial nerve, causing spasm of the muscles of the face. Hence the curetting of the region of the facial canal must be done not only thoroughly, but with care and gentleness. The chief danger arises, I believe, in curetting the posterior part of the inner wall of the tympanum proprium which is overhung by the Fallopian aqueduct. The wall of this canal is here often carious on its antero-internal border, namely, that aspect which looks towards the posterior part of the inner wall of the tympanum.

I have noted during operations and from anatomical preparations that the depth of the recess beneath the Fallopian aqueduct varies greatly. The enclosure of granulations within its bony external, posterior, and internal boundaries accounts for the frequent carious erosion of the bone in this situation. The surgical importance of this portion of the tympanum justifies its being called by a descriptive name, "the fossa of the aqueduct" or "Recessus tympanicus sub-aquæductū Fallopii."

Unless the aqueduct has been eaten away, so that the nerve lies in a mass of infective granulations, or unless the geography of the bone has been obscured by a previous operation or operations by another surgeon, the facial nerve ought never to be injured or in danger of injury. It has happened to me on many occasions to

[1] Notwithstanding the employment of saline infusion, strychnia, etc., this child died about twelve hours after the discovery of the hæmorrhage.

operate on cases in which the aqueduct has been opened more or less by the disease, and in which it was quite



Drawn from a specimen prepared by Hamilton Ballance. The complete mastoid operation has been performed.

1 = Inner wall of antrum.
2 = Inner wall of attic.
3 = Inner wall of tympanum proprium.
4 = Ridge of the aqueduct. Under cover of this is the "recessus tympanicus sub-aquæductū Fallopii." The dotted line indicates the backward and upward extension of the recess.

easy to complete the operation without damage to the nerve.

The cartilaginous canal is next dealt with. The posterior part of its inner extremity has, during the progress of the operation on the bone, been dislocated outwards. I find that it is not satisfactory to treat it as is usually recommended, namely, by splitting it horizontally well out to the concha, and, at the outer extremity of the horizontal cut, making an incision at right angles, thus

forming a rectangular flap, which has to be pushed up and kept up in position by plugs of gauze.

The drawings show better than any description, the method I like best in dealing with the membranous meatus. A long and narrow knife is passed through the canal. The inferior wall of the canal is divided vertically well into the concha. The cut in the concha is then carried with a curve upwards and backwards till it reaches the level of the anterior commencement of the helix. The posterior wall of the meatus is then pushed upwards and backwards, and attached in a special manner by one, two, or three silkworm-gut threads to the mastoid flap, raw surface to raw surface. Before passing these supporting stitches, the thick layer of tissue behind the posterior wall of the meatus is cut away in order to facilitate the application of the meatal flap to the skin flap.[1] The inner extremity of the membranous meatus is usually ragged, and the ragged edges are trimmed with scissors.

The bone cavity is now cleansed[2] repeatedly with an efficient antiseptic, such as 1 in 20 carbolic lotion, dried, and then a narrow strip of iodoform gauze is carefully packed against the inner wall of the attic, tympanum, and antrum, the end being brought out through the enlarged meatus.

The advantages gained by the plugging of the bone cavity are that, while there is no interference with the growth of healthy granulation tissue through and over the bone, the outline of the irregular cavity is maintained, the granulations are prevented from becoming exuberant at any one spot as compared with another, and thus, when the time comes for the grafting operation, a granulating surface of fairly even thickness is prepared as a resting-place for the grafts.

The curved skin wound on the mastoid is entirely

[1] In young children the parts are so small that I think it is best to cut away entirely the conchal portion of the meatal flap.

[2] Absolute phenol may be used with advantage.

closed with fine silkworm gut or horsehair; and thus the height and prominence[1] of the pinna, as compared with that of the opposite side, is maintained, and no deformity results. Further, the ultimate scar of the curved wound behind the pinna being but a thin white line is practically invisible.

In the interval between the first and second operations, the daily change of the outer dressing of gauze soaked in 1 in 40 carbolic lotion is a comfort to the patient. The plug may very often, in adults, be left unchanged. In children, the foulness and extent of the wound in the bone which are associated with the presence of sequestra and cholesteatomous masses render its complete surgical cleansing at the first operation very difficult; and when this is not accomplished the plug must be removed after a few days and the cavity syringed with carbolic or chlorine lotion. Under favourable circumstances the epithelial grafting operation may be done in children at the end of one week; and at the end of ten days, two weeks, or three weeks in adults.

At the end of a week, the stitches uniting the curved skin wound will have been removed, but the deep threads holding the meatal flap in position should be left *in situ* as long as possible.

Description of Second Operation.

Taking the case of an eburnated adult mastoid as the type, the proceeding is as follows:

The day before the operation the plug is removed and the cavity irrigated several times with 1 in 40 carbolic lotion. On the morning of the operation the cavity is washed out three or four times with warm sterile normal

[1] The reflection of the concha and meatus and their attachment to the inner aspect of the mastoid flap is an important aid in the maintenance of the normal prominence of the pinna, especially when the greater part of the mastoid has been destroyed by disease or necessarily removed at the operation.

saline solution. During the operation the only fluid used is the same saline solutions.[1]

The anæsthetic having been given, the original incision is again opened; this being easily accomplished by the handle of the knife before the wound is firmly healed. The pinna is displaced forwards, as in the first operation. Some time must now be taken to arrest all oozing from the granulating surface, so as to obviate dribbling of blood into the bone cavity. All fluid will collect in the deepest part of the cavity, namely, in the tympanum proprium. This may spoil the approximation of the graft to the bone, for the graft will be caused to float, and its edges to curl up. When the graft is once well into position against the bone this does not happen, as the epithelial layer promptly clings to the granulations.

The drying[2] of the tympano-antral cavity may be accomplished by little pieces of dry gauze held on forceps. Every care must be taken to avoid injuring the very delicate and very thin layer of pink tissue which covers the bone. Even the densest ivory bone, which was left white and bare at the first operation, will show a distinct pink colour at the end of a fortnight, and epithelial grafts will adhere to it in a perfect manner.

Large epithelial grafts, as thin as possible, are now taken from the thigh or arm.[3] It is quite easy to cover the roof of antrum and attic and the inner wall of the antrum with one graft, but the main difficulty that has to be overcome is the application of the graft to the inner wall of the tympanum proprium.

If the surgeon is successful in cutting an epithelial graft large enough to cover the whole area of the granu-

[1] I use the following fluid for lubricating the grafting razor:

Saline solution	...	...	℥vij.
Glycerine	...	...	℥ij.
Alcohol	...	...	℥j.

[2] The removal of air and fluid beneath and over the graft can be effected with ease by means of a small pipette.

[3] The razor I use is hollow-ground on both sides; the blade measures five inches in length and two inches in breadth.

lating surface which it is desired to epithelialise, it can be applied with advantage in one piece. The graft is best carried to the wound spread out on a microscope section lifter. These lifters I have had made of steel, nickel-plated, and of various sizes. The anterior extremity of the lifter should be placed against the outer or superficial edge of the anterior wall of the cavity in the bone caused by the first operation.[1] The end of the graft is now coaxed on to this superficial edge, and also above on to the adjoining superficial edge of the roof of the cavity just below the linea temporalis. The upper and anterior edges of the graft thus placed are held in position by the point of a silver probe.[2] The section lifter is gradually withdrawn. By a little skilful manipulation the graft can now be worked from before backwards over the raw bone surface, and be made to cover and lie flat successively against—

(1) The anterior wall of the cavity formed internally by the anterior boundary of the tympanum and attic and externally by the anterior wall of the enlarged osseous meatus.

(2) The anterior part of the roof of the cavity formed by the tegmen tympani and the superior wall of the enlarged osseous meatus.

(3) The inner walls of the attic and tympanum.

(4) The tegmen antri.

(5) The ridge formed by the Fallopian aqueduct, and

(6) The inner wall of the antrum.

If two or more grafts are employed the difficulty of perfectly covering the surface is slightly increased, as when one graft is used the whole cavity is covered with

[1] It will be remembered that the osseous meatus was enlarged upwards at the first operation by the taking away of the upper wall of the meatus, or other words, the outer boundary of the attic as far upwards as the cortical layer which now alone separates osseous meatus from middle fossa.

[2] Needles are used to shift a microscopic section on a glass slide, and they are a most valuable aid in moving an epithelial graft over the tympano-antral cavities.

epithelium. Great care must be taken to avoid the overlapping of, or intervals between, adjoining grafts.

When one large graft is cut, suspended over the cavity from the anterior to the posterior boundary, and pressed home to the inner walls of the attic and tympanum, much difficulty is sometimes experienced in withdrawing drops of blood or bubbles of air which are caught beneath the graft, and which by their presence prevent the close approximation of the epithelium to the bone. This objection to the use of one large graft can be obviated by the inveigling of it edgewise over the depths of the cavity instead of pushing the centre of it, as one is naturally at first inclined to do, directly into the tympanum.

It will be found useful to employ tiny moist gauze pledgets on angular forceps to press the graft or grafts firmly against the bone. By this means, too, blood or small clots can be removed from the surface of the graft and a clear view obtained of its position, so that its accurate approximation to the raw bone surface is facilitated. As an aid in pressing the epithelium firmly against and into the irregular recesses of the bone cavity, I have had made steel probes or "stoppers" with pear-shaped heads, one 6 mm. and the other 4 mm. in diameter. These greatly facilitate that perfection of the approximation between graft and raw bone surface which is the aim of the operator. Moreover the smooth surface of the steel obviates any clinging of the graft to it. This may happen during the employment of a gauze pledget, when the channel leading to the inner surface of the tympanum is unusually narrow. Such an event annoys the operator and delays the operation. There must be no space left between bone and graft. When the grafting is complete, the definition of eminences and depressions should be as clear to the eye as before the operation, the only difference being the epithelial covering.

It seems to me undesirable to graft the posterior part of a very large mastoid cavity; otherwise the per-

manent cavity will be unnecessarily large. The posterior wall of a large mastoid operation cavity has oftentimes not been the seat of disease, and therefore I do not lay so much stress on the immediate healing of it, but this is a question which further experience will throw light upon. The epithelial grafting of the inner surface of the mastoid flap is another point on which I cannot yet give a final opinion. The main effort should be directed to the covering with epithelium of the tegmina and inner walls of both antrum and tympanum, so that these cavities, which have for years been the site and harbour of disease, may be immediately healed, and be for ever accessible for examination through the enlarged meatus.

It is very important to graft the fresh-cut surface of bone which forms the superior wall, and the upper portion of the anterior wall of the enlarged osseous meatus. In two or three of my cases, in which this was not done, this fresh-cut surface of bone threw out granulations in the usual way, and delayed by some weeks the final healing of the cavity.

If two or more grafts are employed a granulation in certain cases appears at some spot between the adjoining edges. This causes no trouble if ordinary means are used to prevent growth till the epithelial cells have had time to swarm over the small ungrafted surface.

In very young children the cutting of a large, thin epithelial graft is not so easy as in adults, as the razor encounters a small limb with considerable convexity instead of a considerable flat surface. The cutting of grafts from babies is almost to subject them to another operation, and, though the risk be *nil*, it is well when possible to take the grafts from another patient.

In children, too, in whom the grafting operation has to be delayed because of the foulness of the wound, the granulations from the vascular cancellous tissue of the mastoid are apt to considerably fill up the antral cavity. Thus the inner boundaries of the attico-tympanal cavities are seen at the grafting operation at the bottom of

a round hole. Such a condition makes it necessary to curette away the redundant granulation tissue, so that a graft may be slid down a gentle incline instead of a steep hill on to the inner wall of the tympanum.

As a protective to the grafts I have experimented with green and blue protective, tin foil, lead foil from a chocolate box, platinum foil, and gold leaf. The requirements of a perfect protective material are (1) that it is soft, and thus readily adapted to the irregular cavity in which it has to be fitted; (2) that it can easily be sterilised; and (3) that it is not acted on by the living tissues and fluids. Lead is acted on by the living tissues and fluids; pure gold and pure platinum are not; tin and platinum foil are rather rigid. On the whole, I think pure gold leaf is the best material, about $\frac{1}{16000}$ to $\frac{1}{20000}$ of an inch in thickness. The cost is about threepence per square inch.[1] The gold-leaf is carefully pushed into position; and again the definition of the various parts of the irregular bone cavity should be clear, proving that the protective material has been pressed home. A narrow strip of dry iodoform gauze is now packed into attic, tympanum, and antrum, and the end brought out through the meatus. The mastoid flap is completely closed as before, and the outside dressings applied.

A week later the plug is removed. It comes out quite easily and without pain, as it has occupied the concave aspect of the gold leaf. On illuminating the cavity the gold leaf is seen outlining antrum, attic, and tympanum. The gold leaf may be left undisturbed for three or four more days. It can then be removed with forceps, after gentle irrigation, when the irregular grafted cavity comes into view, white in colour. A little dry gauze is packed in against the grafts, and should be changed every two or three days till the healing process is complete.

All discharge does not, of course, cease till the un-

[1] The cost would probably be much less if the gold-leaf was obtained direct from the manufacturer.

grafted area behind and below the antrum and on the inner surface of the mastoid flap skins over. The last part to heal is the cut edge of the cartilage of the concha, which throws out very exuberant granulations.[1]

The epithelial grafts, at first white, shed their epithelium several times, till, I suppose, the epithelial cells get accustomed to their new function. This may be compared to that of periosteum or dura, namely, the coating and protection of a bony surface. When all active healing changes are accomplished the cavity is quite dry, and light pink in colour.

There are two questions which naturally arise in connection with the epithelial grafting of the tympano-antral cavities:

1. Does it affect the hearing power? In regard to this point, as far as I can judge, the result is much the same as after the longer and older method of dry gauze tamponning. It is well known that a patient with chronic otorrhœa and partial or complete tympanic deafness, often hears much better after the operation, and I see no reason why epithelial grafting will affect this result one way or the other.[2]

2. It may be asked, does the epithelial graft close the Eustachian opening? Undoubtedly it may do so. The function of this tube in health is to act as a conduit for air into the tympanum, and for the escape of mucus from that cavity. The first function is unnecessary, as the drum is gone, and the second is of no account, as there is no mucous membrane left to secrete. The closing of the

[1] On several occasions I have used epithelial grafts the size of a shilling (taken from the operating theatre) to heal the cut edge of the cartilage; and it is not difficult to fit them against any unhealed surface, *e.g.* a part of inner wall of tympanum by manipulation through the enlarged meatus. This plan is a poor substitute for the epithelial grafting operation described in this paper.

[2] June, 1900.—Some of my patients have recovered their hearing to a remarkable extent. This is due, I think, to the very thin layer of new tissue over the fenestra ovalis. Hence the new operation from this point of view is better than the old.

Eustachian tube, then, can do no harm, and may be useful in preventing the entrance of pathogenic organisms from the throat.

Lastly, the main object of the paper is to advocate in all operations for chronic purulent otorrhœa the systematic adoption of epithelial grafting for the immediate closure of the bone wound.[1]

Short Abstract of the Notes of all the Cases in which the Writer has employed Epithelial Grafts for the Immediate Healing of the Cavity in the Bone caused by the Complete Mastoid Operation.

Many of the cases were kept in hospital much longer than was really necessary, so that observations should be made of the behaviour of the epithelial grafts applied to the raw bone surface.

Cases marked thus (*) were exhibited at the meeting of the Society on January 23rd, 1900.

Case 1 (St. Thomas's Hospital).—J. J—, male, aged 6. Admitted April 15th, 1899.

History.—Has had discharge from right ear for four years. Last year after measles and diphtheria it became worse. Two weeks ago a tender swelling appeared behind right ear.

Present condition.—Profuse discharge of bad odour from right ear and mastoid abscess. Postero-inferior half of drum gone.

April 15th.—Complete mastoid operation. Caries, sequestrum, offensive granulations and pus removed. Lateral sinus exposed by disease; dura granulating.

21st.—Epithelial grafting operation. Two grafts employed.

May 3rd.—Plug removed. Grafts adherent.

16th.—Discharged cured.

Case 2.—Miss B—, aged 19; patient of Dr. Corner.

History.—Scarlet fever at age of six years; since then discharge from left ear off and on. For last three weeks there has been constant pain in left ear and left temporal region,

[1] In order still further to hasten the healing process, I suggest that at either the first or second operation the following raw surfaces should be grafted:—(1) The inner surface of the mastoid flap corresponding to the opening in the bone which is not covered by the skin of the meatal flap; (2) The cut edge of the cartilage of the concha.

associated with vertigo and ringing tinnitus. Various treatment had been tried in vain.

Present condition.—Slight offensive discharge in meatus; posterior three quarters of drum absent; caries discovered by bent probe towards posterior and upper part of tympanum.

May 9th, 1899.—Complete mastoid operation. Some difficulty in operation, as sinus nearly reached posterior wall of osseous meatus, and edge of middle fossa much overlapped outer side of antrum.

27th.—Epithelial grafting operation.

June 6th.—Grafts taken admirably.

September 28th.—Cavity quite dry, but an adhesion band has formed at inner extremity of osseous meatus, partly obscuring view of inner surface of tympanum proprium. This was removed under cocaine.

October 20th.—Condition perfect.

Case 3 (St. Thomas's Hospital).—P. M—, female, aged 37. Admitted December 18th, 1898. Sent by Dr. H. A. Sansom.

History.—Following influenza three months ago there has been discharge from, and pain in right ear.

Present condition.—Discharge in right meatus, and a group of granulations springing from posterior wall of osseous meatus. Small perforation in drum. Beneath granulations a probe impinged on carious bone.

December 21st.—Antrum opened. Tympanum not interfered with. Below antrum was another cavity, which communicated with antrum above and osseous meatus in front. The cavities contained pus and granulations. The operation was completed in the usual way.

Patient left hospital January 10th, 1899. Was readmitted on May 29th. Slight discharge has persisted since she left hospital, and granulations have again appeared in meatus. There has been a good deal of mastoid pain during the last two or three weeks.

May 31st.—Complete mastoid operation.

June 16th.—Epithelial grafting operation (first stage). The pinna was thrown forwards and some exuberant granulations removed. The oozing of blood from the granulations was free, and so it was decided to tampon the cavity and apply the grafts the following day.

17th.—Epithelial grafting operation (second stage). On removing the gauze plug the cavity was quite dry, and epithelial grafts were applied without any difficulty.

26th.—Plug removed. All the grafts seem to have taken well.

July 4th.—Patient left the hospital.

August 25th.—Readmitted. On examination it was found that the whole cavity was healed with the exception of the lower three fourths of the inner wall of the tympanum proprium, which was granulating.

26th.—Epithelial grafting operation. The original incision was again opened, the granulating surface curetted, and an epithelial graft applied.

September 4th.—Tampon removed. Graft adherent.

December 10th.—Patient seen; the last operation has completed the healing of the bone wound.

Case 4.—Mr. K—, aged 44. Seen in consultation with Dr. Stawell, Professor Fitzgerald, and Sir William Dalby.

History.—Discharge from right ear off and on ever since he was at Eton. Slight right facial palsy occurred at Eton and Oxford, but was recovered from on each occasion. Two weeks ago severe pain in the right ear, and complete right facial palsy supervened, and has continued since. During this two weeks a good deal of morphia has been administered. Absolute deafness right ear.

Present condition.—Complete right facial palsy; total deafness right ear; slight fœtid discharge in meatus; inner extremity of meatus nearly blocked by bony growth from posterior wall; face flushed; temp. 100° F.; no mastoid signs; no optic neuritis.

July 11th, 1899.—Complete mastoid operation. Behind the bridge was a small abscess with a thick wall, which was leaking. The antrum and tympanum contained fœtid pus and granulations; their walls were carious. The aqueduct was open and carious on its antero-internal aspect, exposing the facial nerve. The round bony growth blocking the inner extremity of the osseous meatus was attached to the posterior part of the tympanic ring and wall of aqueduct, and projected forwards, leaving only a narrow crescent-shaped lumen between its anterior border and the anterior part of the inner extremity of the osseous meatus.

August 6th.—Epithelial grafting operation. For reasons which it is not necessary to specify the grafting operation had to be postponed to this date.

9th.—Removed plug.

12th.—Removed gold-leaf; bone cavity covered with adherent grafts.

17th.—Left for the sea-side; bone cavity healed.

November 16th.—Condition most satisfactory; walls of bone cavity light pink in colour; no desquamation.

Case 5 (The Hospital for Sick Children, Great Ormond Street).—G. A—, female, aged 11; admitted March 3rd, 1899.

History.—Three years' free purulent discharge from right ear.

Present condition.—Large masto-squamous abscess right side; abscess was incised on admission.

March 29th.—Antrum opened, and much carious bone and granulation tissue removed.

April 4th.—Discharged from hospital.

July 27th.—Readmitted with persistent offensive otorrhœa and small abscess bulging scar over mastoid.

August 4th.—House surgeon opened abscess and scraped mastoid sinus.

12th.—Transferred to my care.

16th.—Complete mastoid operation. Much carious bone and infective granulation tissue removed.

23rd.—Epithelial grafting operation.

September 1st.—All the grafts are adherent, and have taken well.

17th.—Discharged cured.

*Case 6 (St. Thomas's Hospital).—W. R—, male, aged 24. Admitted July 29th, 1899. Sent by Dr. Green, of Romford.

History.—Scarlet fever at age of twelve; the right ear has discharged ever since. A year ago began to suffer from headache, mostly on the right side; also occasional vertigo and staggering gait.

Present condition.—Foul discharge in right meatus and from right Eustachian tube; the latter causes nausea; tympanum granulating; total deafness of affected ear; no optic neuritis; some lateral nystagmus on looking to left; right knee-jerk absent.

August 12th.—Complete mastoid operation.

21st.—Plug removed.

25th.—Epithelial grafting operation. Gold-leaf used as protective.

September 1st.—Plug and gold-leaf removed.

6th.—Discharged cured.

December 13th.—Seen at hospital. Result perfect.

Case 7 (St Thomas's Hospital) —D. C—, female, aged 2½. Admitted June 13th, 1899.

History.—Measles one year ago; discharge from both ears since. Three weeks ago fever, quick pulse, vomiting, rigidity and retraction of head, and profuse discharge from both ears.

Present condition.—Temp. 103·2°, pulse 130. Much discharge from both ears; child seems in pain; head retracted. Mr. Lawford reported "iridocyclitis probably septic in right eye; no view obtained of left."

June 16th.—Antrum opened on each side to give free posterior drainage to tympanum. Both cavities contained granulation tissue and thin pus. The condition of the child was greatly improved by the operation, but three weeks later certain symptoms arose which led Mr. Wallace, in my absence, to explore the cerebellum on the left side. No abscess was found, but a considerable quantity of cerebro-spinal fluid was evacuated. On my return to the hospital the child was much better and without fever, but about August 15th serious symptoms again arose, and the child began to lose flesh. The right ear was dry, but thin pus was still coming from the left meatus.

August 25th.—Complete mastoid operation (left). On exploration the whole mastoid was found disorganised with pus and granulation tissue; hence this operation.

September 1st.—Epithelial grafting operation. Grafts taken from an adult patient.

7th.—Plug removed.

17th.—Gold-leaf removed.

25th.—No discharge. Child improving rapidly and gaining weight.

October 11th.—Discharged cured.

December 28th.—Seen at hospital. Result perfect.

*Case 8.—Mrs. P—, aged 42. Sent by Dr. Eastes, of Folkestone.

History.—Has had discharge from right ear ever since childhood. The first occurrence of discharge followed an attack of measles. Pain in the ear is sometimes severe, and has been accompanied with vertigo and vomiting; fifteen years ago she saw Sir William Dalby, who told her husband her life was in great danger.

Present condition.—Slight offensive discharge from right ear; drum granulating, and there is a central opening which is in part obstructed. Pus is oozing from pharyngeal opening of Eustachian tube; pus sometimes comes through the right nostril; no optic neuritis; watch two inches; no mastoid signs.

September 8th, 1899.—Complete mastoid operation. Tympanum and antrum enlarged by cholesteatoma; roof of antrum absent; walls of tympanum and antrum carious; Sir William Dalby was present.

26th.—Epithelial grafting operation. This operation was delayed by my absence from London; two grafts were used.

October 1st.—Plug and gold-leaf removed. The whole bone area is covered by the adherent grafts.

31st.—Patient examined by Sir William Dalby, Mr. Cumberbatch, and several other medical men, who all agreed that the healing process was complete.

December 21st.—Dr. Heygate Vernon, of Bournemouth, reported that the result of operation was perfect.

January 23rd, 1900.—Watch heard at three inches.

Case 9 (The Hospital for Sick Children, Great Ormond Street).—H. W—, male, aged 4½; admitted September 13th, 1899.

History.—In January last he had scarlet fever, which was followed by otorrhœa. In hospital last April with left otorrhœa and left mastoid abscess; the abscess was incised and the antrum opened.

Present condition.—Small abscess in scar over mastoid; foul left otorrhœa, which has continued since last operation; skin over mastoid mostly destroyed; house surgeon opened abscess over mastoid on admission.

September 30th.—Complete mastoid operation. Condition very foul; caries and sequestra removed; a flap of skin was slid forwards to cover mastoid region.

October 4th.—Epithelial grafting operation.

12th.—Grafts have all taken.

27th.—Relief incision closed; bone wound quite healed.

November 4th.—Discharged cured.

Case 10 (The Hospital for Sick Children, Great Ormond Street).—N. D—, male, aged 4 months; admitted September 29th, 1899.

History.—Foul discharge from left ear for two months; swelling over left mastoid one week.

Present condition.—Left mastoid abscess and profuse foul otorrhœa.

September 30th.—Complete mastoid operation. Several sequestra removed, also carious bone and foul granulations.

October 10th.—Wound very foul; still unfit for grafting.

19th.—Epithelial grafting operation.

27th.—Gold-leaf removed.

November 8th.—No discharge; bone wound healed.

11th.—Discharged cured.

Case 11 (The Hospital for Sick Children, Great Ormond Street).—W. M—, male, aged 4½; admitted August 25th, 1899.

History.—In hospital in July, 1898, with offensive right otorrhœa and large right masto-squamous abscess. Abscess was incised, carious bone removed, and antrum opened.

Present condition.—Pain in and offensive discharge from right ear. Abscess bulging scar over right mastoid.

August 26th.—Complete mastoid operation.

September 14th.—Resident medical officer applied grafts.

30th.—Discharge continuing, wound was examined by me. A part only of the cavity was epithelialised and the granulations around were curetted so as to prepare the cavity for another grafting operation.

October 10th.—Epithelial grafting operation.

27th.—Gold-leaf removed. Cavity covered with adherent grafts.

November 10th.—Cavity dry; healing completed.

11th.—Discharged cured.

Case 12 (The Hospital for Sick Children, Great Ormond Street).—C. T— male, aged 2 years 1 month. Admitted September 25th, 1899.

History.—In hospital last April with right mastoid abscess and foul otorrhœa. The otorrhœa had commenced two months before during an attack of measles. There was also pain, some fever, enlarged glands right side of neck, and right facial palsy. The abscess was opened, a large sequestrum removed, and the antrum exposed.

Present condition.—Right-sided foul otorrhœa, which has continued since previous operation. The mastoid wound has healed, and there is now no facial palsy.

September 30th.—Complete mastoid operation. Pus, granulations, and carious bone removed. Much dura exposed. Aqueduct open, facial nerve seen.

October 10th.—Wound examined under chloroform, as it was very foul. Repeated cleansings with 1 in 20 carbolic.

19th.—Epithelial grafting operation. Much exuberant granulation material removed as a preliminary to the application of the grafts.

25th.—Gauze plug removed.

27th.—Gold-leaf removed. All the grafts adherent.

November 10th.—No discharge, bone wound healed.

December 5th.—Discharged cured.

Case 13.—Miss E—, aged 24, patient of Dr. Blatherwick, Dr. Dixon, and Mr. Cumberbatch.

History.—At the age of nine and a half years suffered from scarlet fever. Discharge often offensive from right ear ever since. Has had various minor operations for removal of granulations, ossicles, etc. In recent years there have been many attacks of malaise, with fever, pain, and vertigo.

Present condition.—Face pale. Watch not heard even on contact, and tuning-fork by bone conduction heard less than on left side. Slight offensive discharge. Drum absent. Cholesteatoma in tympanum. No mastoid signs. No optic neuritis.

October 18th.—Complete mastoid operation. Cholesteatomatous deposit and fœtid granulations in antrum and tympanum. Facial nerve exposed in the fossa of the aqueduct.

20th.—Slight right facial palsy.

27th.—Complete right facial palsy, which lasted about two weeks. By the end of November the palsy had practically disappeared.

31st.—Epithelial grafting operation. The question arose

whether the grafting should be done at the usual time, or postponed in consequence of the facial palsy. The operation was not delayed, because it was thought that it was better to have a healed surface rather than a purulent secretion in contact with the inflamed nerve.

November 6th.—Plug removed.

8th.—Gold-leaf removed. All the grafts have taken.

30th.—With the exception of a small area of the inner surface of the flap the whole cavity is healed.

January 12th, 1900.—Examined patient with Dr. Dixon. Whole cavity light pink in colour. No sign of epithelial desquamation. Tuning-fork heard by bone conduction louder on right than left side. Watch not heard. Surgical state appears perfect.

*Case 14 (St. Thomas's Hospital; sent by Dr. Evan Jones, of Aberdare).—E. M—, aged 19; admitted November 12th, 1897.

History.—Intractable otorrhœa (left) since measles at age of five years; pus often offensive; pain in ear and vertigo very frequent of late.

Present condition.—Free purulent discharge from left ear; tympanum granulating; no drum or ossicles present.

November 20th, 1897.—Complete mastoid operation. Subsequent treatment: dry gauze tamponning.

December 7th.—Left hospital.

October 20th, 1899.—Readmitted.

Present condition. –Bone cavity healed except tympanum proprium, which is granulating. He has never been free of discharge since last operation, though for months he was carefully treated by dry gauze tamponning by his doctor.

21st.—Operation. Old incision opened; antrum healed; attic and tympanum curetted and left bare of all soft tissue.

27th.—Plug taken out.

28th.—Operation. Pinna turned forwards again. Bone very white. It was determined to postpone the grafting.

November 4th.—Epithelial grafting operation. Bone is now light pink in colour. Three grafts used; more difficulty than usual in their application to the raw bone surface.

9th.—Plug and gold-leaf removed. Grafts have taken well.

15th.—No discharge. Went home.

January 10th, 1900.—Readmitted with slight discharge from ear. At the inner extremity of the osseous meatus there was a small piece of gauze, into which a granulation springing from the front wall of the bone cavity had grown. This was removed and the raw surface grafted.

16th.—Plug and gold-leaf removed; graft adherent.

23rd.—Healing complete.

Case 15 (The Hospital for Sick Children, Great Ormond Street).—H. E—, male, aged $4\frac{3}{4}$. Admitted October 19th, 1899.

History.—In hospital in July, 1897, with left masto-squamous abscess following measles. Abscess was incised and antrum opened. Since then has had persistent discharge from left ear.

Present condition.—Purulent discharge from left ear, and abscess bulging scar over mastoid.

October 20th.—Complete mastoid operation. Several sequestra and much carious bone removed. Much granulating dura exposed.

November 7th.—Epithelial grafting operation. The grafting operation was delayed by the serious symptoms which appeared and persisted for five or six days after the operation on October 20th. They were fever, vomiting, headache, nystagmus, and staggering gait.

27th.—Bone cavity quite healed. Grafted area white. No trace of discharge.

December 30th.—Left hospital cured.

*Case 16 (St. Thomas's Hospital).—E. N—, female, aged 12; admitted October 30th, 1899.

History.—Four years ago was hit behind left ear by a snowball which contained a stone. This is said to have been followed by a discharge from the ear and a swelling over the mastoid. Two years ago an abscess over mastoid was incised by a doctor.

Present condition.—Two sinuses over left mastoid, through which bare bone can be detected with the probe. Some pus coming from meatus; watch and tuning-fork cannot be heard left side. Only circumference of drum left; mother says patient has been absent-minded lately.

November 3rd.—Complete mastoid operation. Carious bone and sequestra removed. The antrum contained much inspissated pus, and the whole area of operation was very foul.

7th.—Plug removed, as it was very foul.

14th.—Epithelial grafting operation. Some irregular and exuberant granulations were scraped away. Three epithelial grafts employed; gold-leaf was used as the protective.

19th.—Plug removed.

22nd.—Gold-leaf removed; cavity white and completely covered with adherent grafts.

29th.—Slight discharge from cut edges of concha.

December 7th.—Healing of bone cavity perfect. Slight discharge from inner aspect of flap.

20th.—Healing complete; watch heard two inches from ear. Cavity becoming light pink in colour.

Case 17 (The Hospital for Sick Children, Great Ormond Street).—G. S—, female, aged 9 months, admitted October 13th, 1899.

History.—Has had discharge of offensive pus from both ears for eight months. At the age of two months an abscess formed behind the *left ear*, which was opened, a sinus remaining ever since. One week ago an abscess formed behind right ear.

Present condition.—Right masto-squamous abscess and discharging sinus over left mastoid.

November 6th.—Complete mastoid operation (right side).

20th.—Epithelial grafting operation (right side). Much granulation tissue had to be removed so as to define the antrum before the application of the grafts.

28th.—Complete mastoid operation (left side) and immediate application of epithelial grafts. A sequestrum was removed, and the disease was very extensive, but as the bone seemed very vascular the grafts were applied immediately. This prolonged the period of chloroform anæsthesia unduly, and I should not do this again in so young a child. On examining right ear it was seen that all the grafts had taken.

December 5th.—Plug removed (left side).

8th.—Gold-leaf removed. Whole bone cavity covered with adherent epithelial grafts. Right side quite healed.

30th.—Discharged cured.

DESCRIPTION OF PLATE II,

Illustrating the Conduct of the Mastoid Operation for the Cure of Chronic Purulent Otorrhœa (CHARLES A. BALLANCE).

FIG. 4. Ordinary round cavity burr.

FIG. 3. Round cross-cut cavity burr.

FIG. 2. End view of cross-cut cavity burr, so made that it will cut in the direction of its axis.

FIG. 1. "Protector" fitted to hand-piece. The cup of the protector is shown shielding more than one half of the burr.

FIG. 7. Cryer's spiral osteotome and support.

FIG. 6. Cross-cut fissure burr with Cryer's support. To the hand-piece is fixed a watering-pot arrangement which I have designed for the purpose of keeping the bone moist while the burr is in action. This will be found useful whether a round or fissure burr is being employed.

FIG. 5. Cross-cut fissure burrs terminating in smooth steel ends. They are valuable aids in removing the "bridge" and outer wall of the attic. Cryer's support is often too bulky to be of service.

FIG. 1.

FIG. 2.

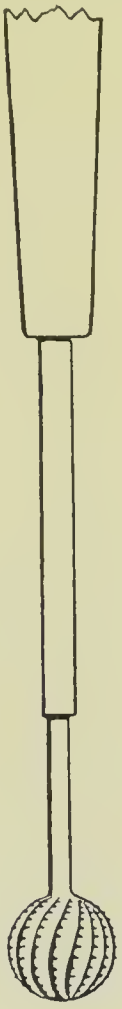
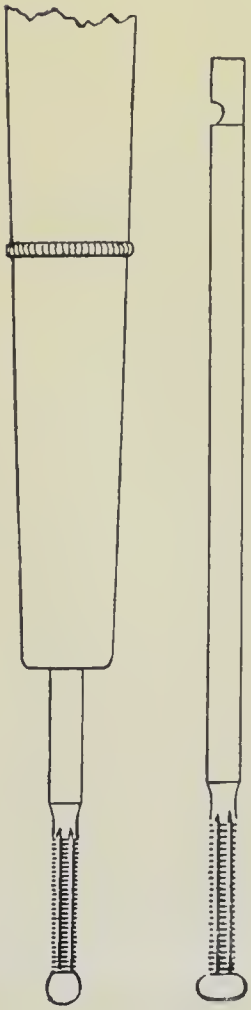
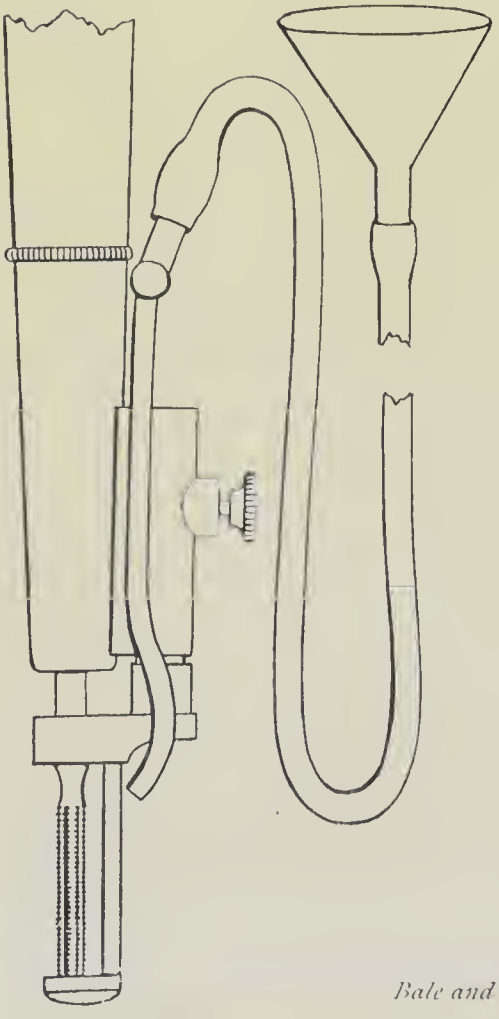


FIG. 3.

FIG. 4.





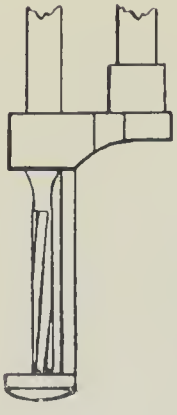


FIG. 7.

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Plate IV.

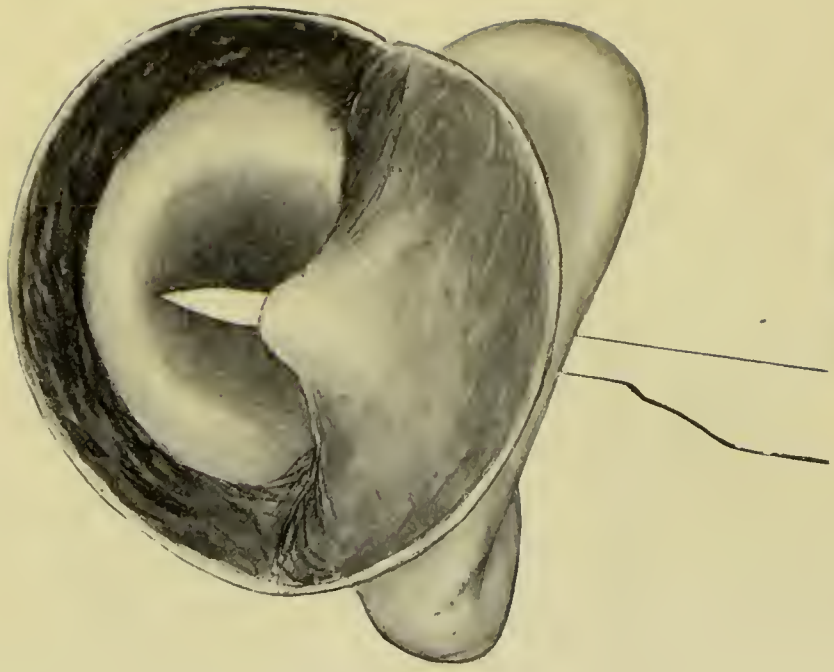

FIG. 1.

FIG. 2.

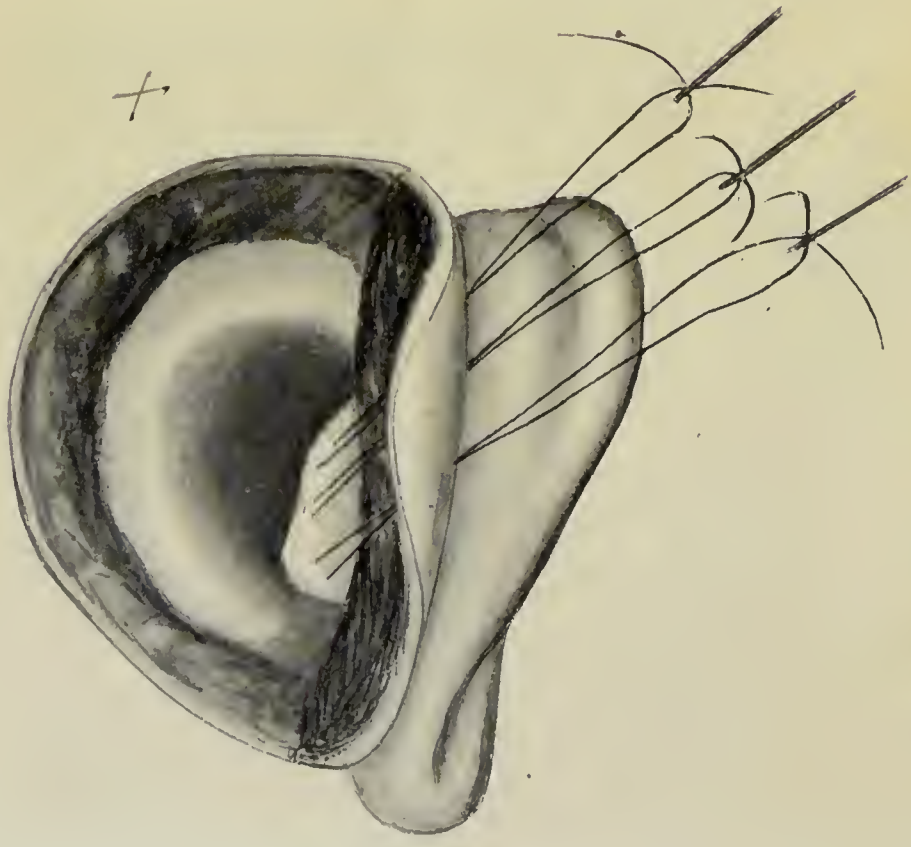

FIG. 3.

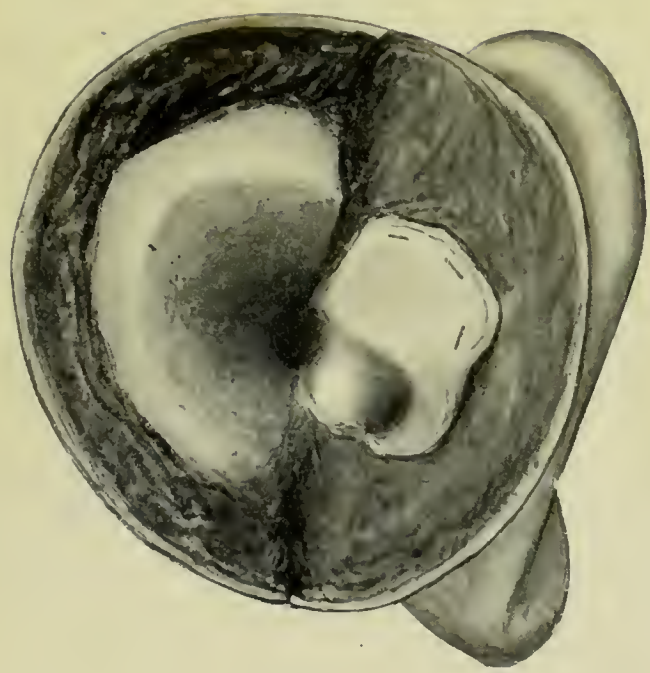

FIG. 4.

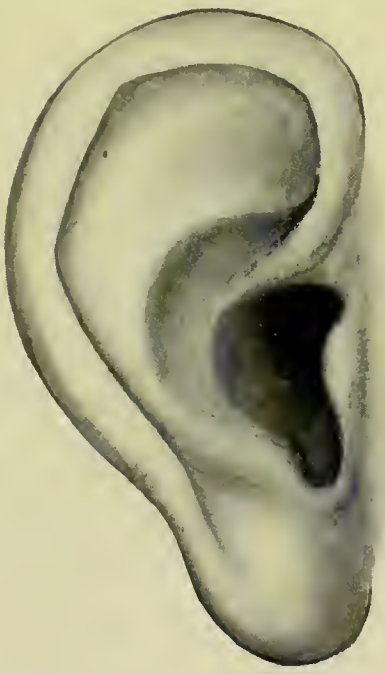

FIG 6.

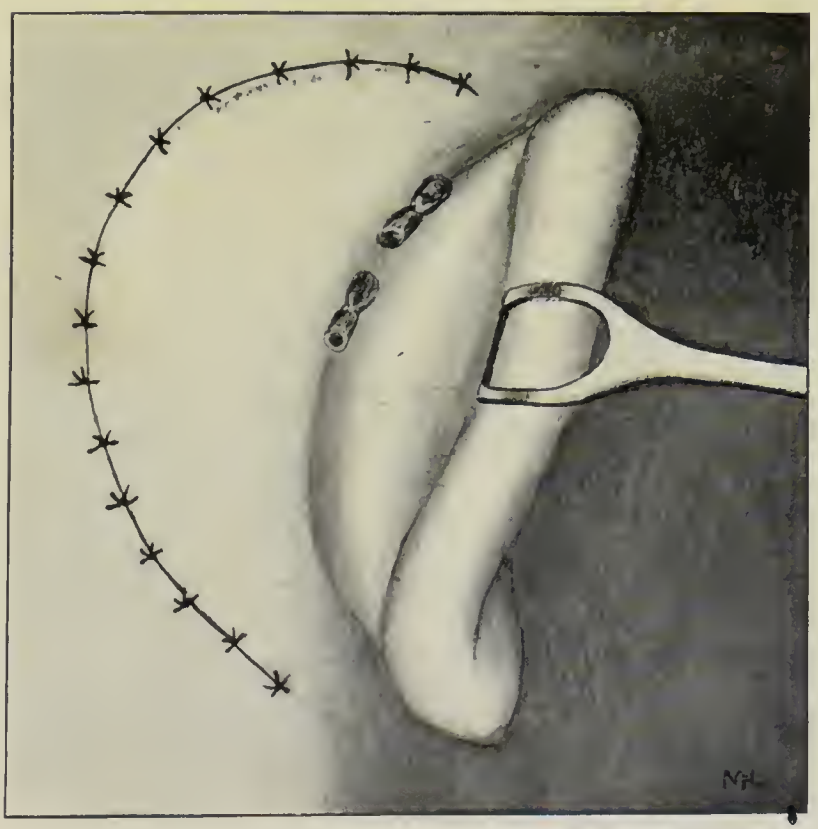

FIG. 5.

DESCRIPTION OF PLATE V.

Illustrating the Conduct of the Mastoid Operation for the Cure of Chronic Purulent Otorrhœa (CHARLES A. BALLANCE).

W. H. C. Staveley's ingenious plan of supporting the pinna during the healing of the wound. The threads can be untied and the dressing of the skin incision applied underneath them. Useful after the operation for acute cases.

FIG. 1. The strapping for the temporal region.

FIG. 2. The strapping for the pinna.

FIG. 3. The strapping in position; one thread tied and the other about to be tied.

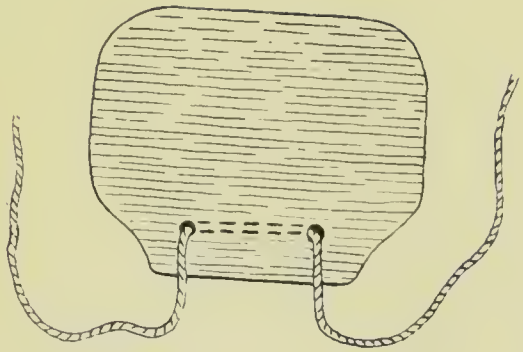

FIG. 1.

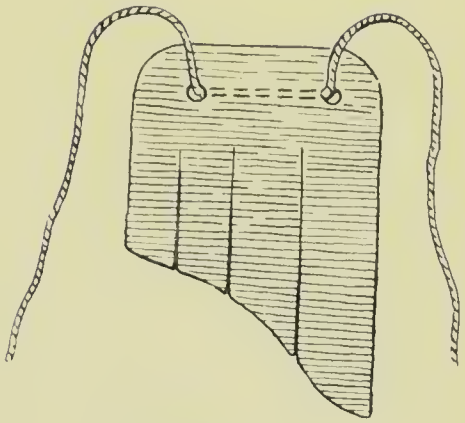

FIG. 2.

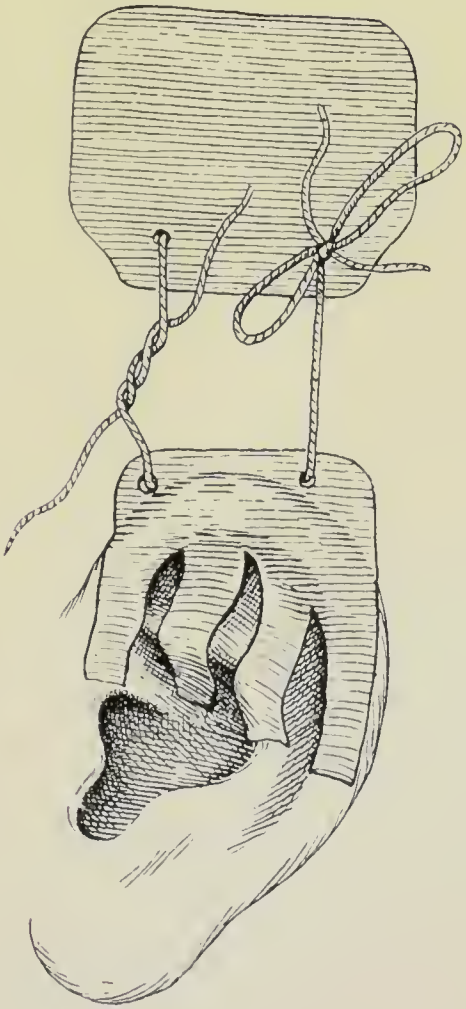

FIG. 3.

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DESCRIPTION OF PLATE VI.

Illustrating the Conduct of the Mastoid Operation for the Cure of Chronic Purulent Otorrhœa (CHARLES A. BALLANCE).

To illustrate the method of applying the epithelial graft to the tympano-antral cavities.

FIG. 1. The cavities prepared for the graft. The bleeding has ceased. Note the outline of the inner walls of antrum, attic, and tympanum. The ridge of the aqueduct is also visible.

FIG. 2. The epithelial graft spread out on the lifter. The anterior edge of the graft is held against the superficial edge of the operation cavity as the lifter is withdrawn.

FIG. 3. The lifter has been withdrawn. The anterior edge of the graft is held in position while the pipette is inveigled beneath it. The suction of air and fluid from beneath the graft causes it to be forced by the atmospheric pressure against the inner walls of the tympano-antral cavities. The graft shown is not nearly wide enough to cover the whole of the raw bone surface. The superior wall of the cavity is of considerable superficial area.

FIG. 4. The graft in position. Note that when the graft is perfectly applied to the raw bone surface the inner walls of the tympano-antral cavities are defined as clearly as before.

FIG. 5. The gold leaf in position.

C = Superficial edge of operation cavity.
E = Epithelial graft.
G = Gold leaf.

Note that the outline of the tympano-antral cavities and the ridge of the aqueduct is still clear and distinct.

Plate VI.

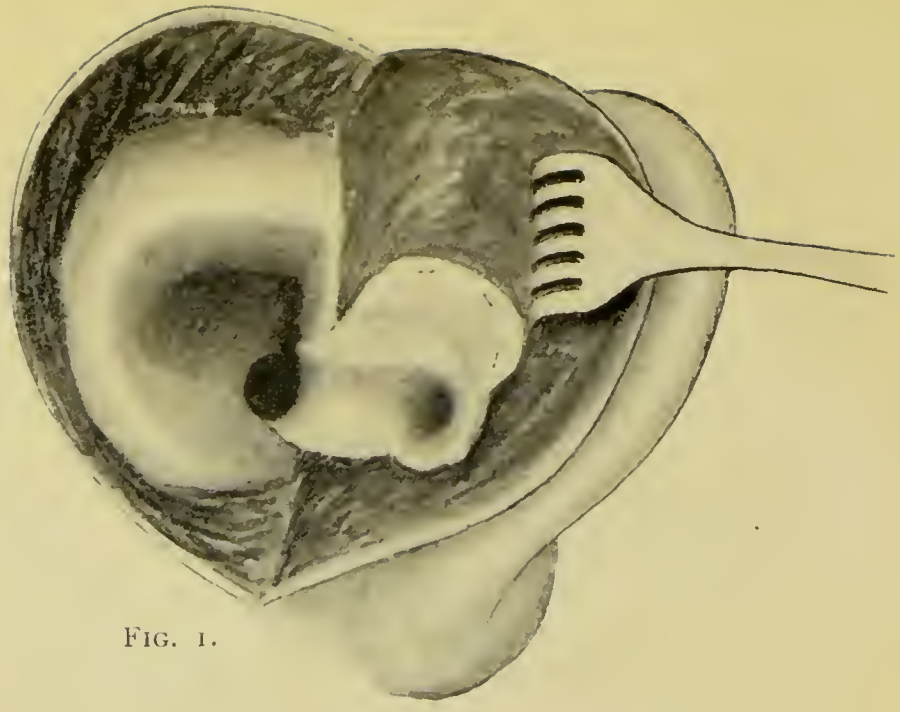

FIG. 1.

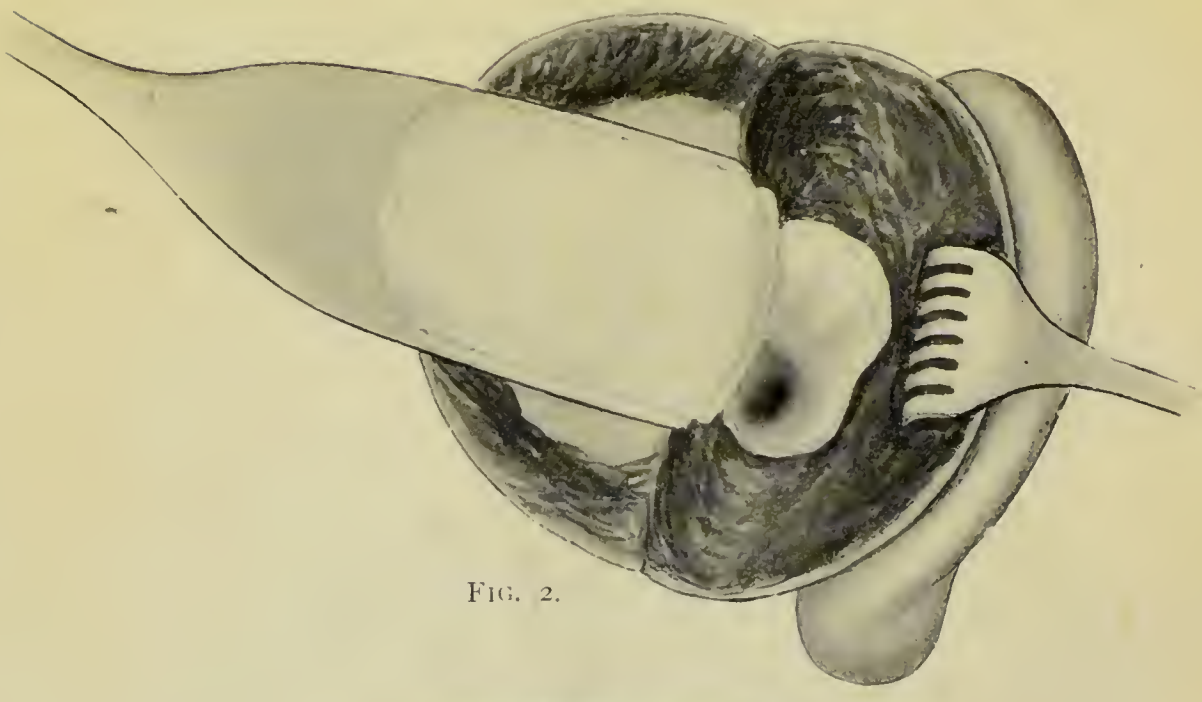

FIG. 2.

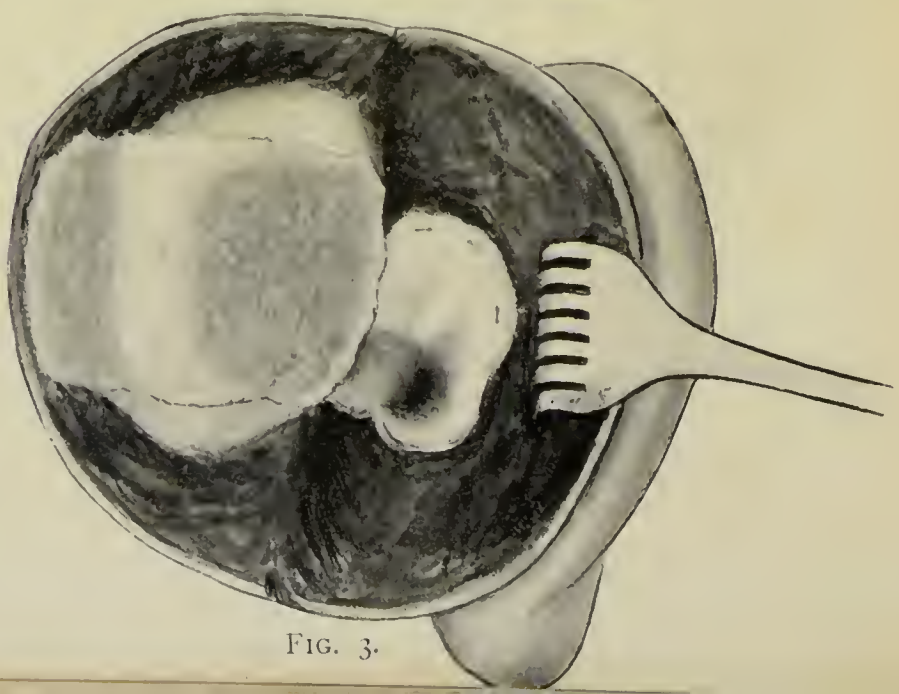

FIG. 3.

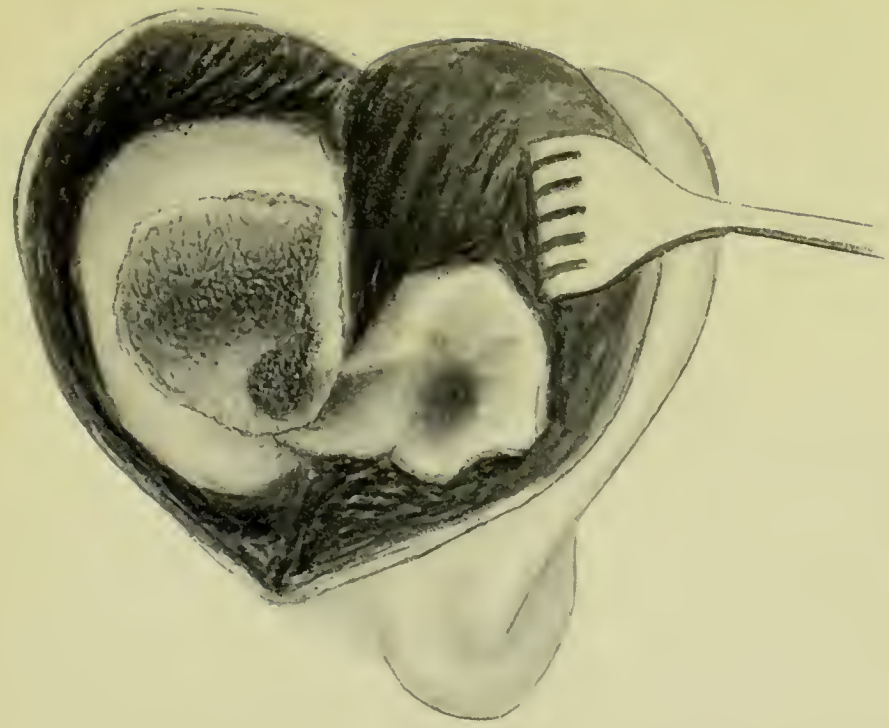

FIG. 4.

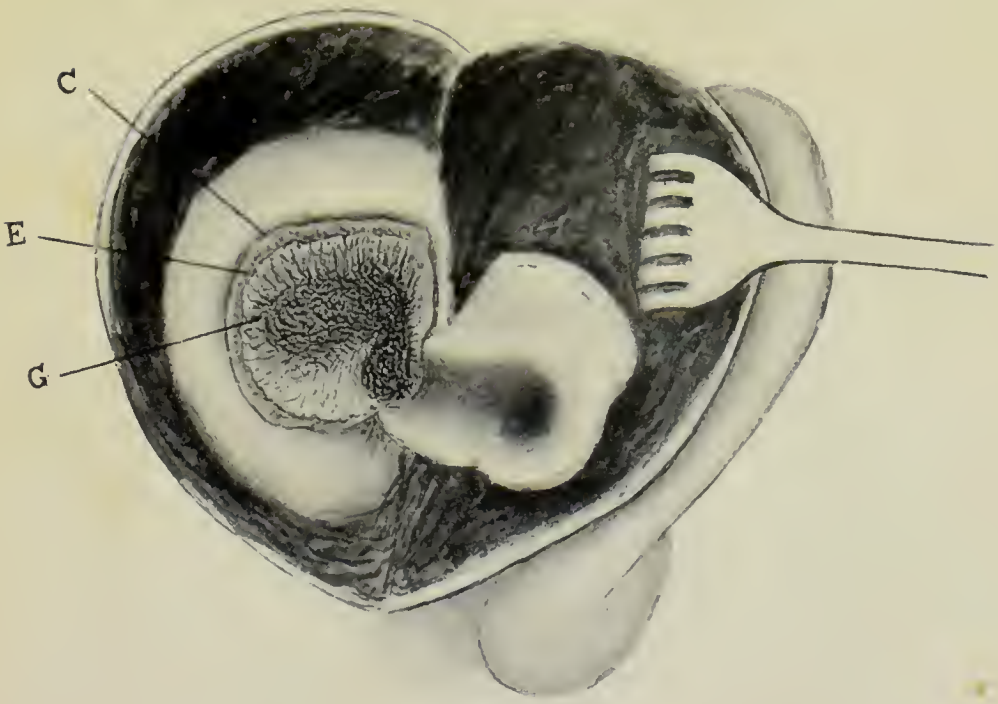

FIG. 5.

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